



The Effect of Successful Right Coronary Angioplasty on Early Term Right Ventricular Functions

Başarılı Sağ Koroner Anjiyoplastinin Erken Dönem Sağ Ventrikül Fonksiyonları Üzerine Etkisi

Sağ Koroner Angioplasti ve Sağ Ventrikül Fonksiyonları / Right Coronary Angioplasty and Right Ventricular Functions

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Özet

Amaç: Biz bu çalışmamızda tek damar izole proksimal sağ koroner arter (RCA) lezyonlarında elektif perkütan transluminal koroner anjiyoplastinin (PTKA) sağ ventrikül sistolik fonksiyonlarına etkisini izovolümetrik akselerasyon zamanı ile değerlendirerek diğer ekokardiyografik yöntemlerle karşılaştırmayı amaçladık. **Gereç ve Yöntem:** Kararlı koroner arter hastalığı ön tanısı ile koroner anjiyografi uygulanan, sağ koroner arter proksimal lezyonu tespit edilen ve elektif PTKA amacıyla yatırılan sol ventrikül ve sağ ventrikül fonksiyonları korunmuş, miyokard infarktüsü geçirmemiş, ek hastalığı bulunmayan yaşları ortalama 57.6±9 yıl olan (29 erkek, 4 kadın) toplam 33 olgu dahil edildi. Olguların tamamına işlem öncesi ve işlemden sonra 24 saat içinde transtorasik ekokardiyografik inceleme yapıldı. Ekokardiyografik inceleme ile doku Doppler ile triküspit annüler izovolümetrik miyokardiyal akselerasyon (İVA) zamanı, sağ ventrikül fonksiyonlarını gösteren triküspit doluğu paterni, sağ ventriküler triküspit annüler düzlem sistolik hareketleri (TAPSE), sağ ventriküler miyokardiyal performans indeks (MPI) değerleri kaydedildi. **Bulgular:** Sağ ventrikül fonksiyonları değerlendirildiğinde PTKA işleminden sonra sağ ventrikül MPI TAPSE, İVA değerlerinde anlamlı değişiklik olduğu gözlemlendi. İşlem öncesi 0.39±0.64 olan MPI'nin işlem sonrası 0.37±0.61 (p=0.05) olduğu, işlem öncesi 2.7±0.4 olan TAPSE değerinin işlem sonrası 2.9±0.3 olduğu (p=0.01), işlem öncesi 4.1±1.6 olan sağ ventrikül İVA değerinin işlem sonrası 5.5±2.2 (p=0.0001) olduğu tespit edildi. **Tartışma:** Başarılı revaskülarizasyon işleminin sağ ventrikül fonksiyonlarında daha da belirgin iyileşme sağladığı ve bu iyileşmenin doku Doppler yöntemi olan İVA ile objektif olarak saptanabileceği çalışmamızda gösterilmiş oldu.

Anahtar Kelimeler

Sağ Ventrikül; Anjiyoplasti; Koroner Arter Hastalığı

Abstract

Aim: We aimed to investigate the effect of elective percutan transluminal coronary angioplasty on right ventricular systolic functions using isovolümetric acceleration time in patients with isolated proximal right coronary artery (RCA) lesions and compare this method with other echocardiographic methods. **Material and Method:** 33 patients (29 men and 4 women) were selected among patients whose angiographies had been performed for stable coronary artery disease and who were admitted for elective PTCA. These patients were patients with isolated proximal RCA lesions and preserved left and right ventricular functions. The selected patients had no history of myocardial infarction or comorbid diseases. The mean age was 57.6±9 years. All patients were evaluated by transthoracic echocardiography before and within 24 hours after the process. Tricuspid annular isovolümetric myocardial acceleration time (IVA) determined by tissue Doppler, tricuspid filling pattern, tricuspid annular plane systolic excursion (TAPSE), right ventricular myocardial performance index (MPI) values which shows right ventricular functions, were noted. **Results:** When right ventricular functions were evaluated we found significant difference for right ventricular MPI, TAPSE and IVA values after PTCA process. MPI value was 0.39±0.64 before PTCA and 0.37±0.61 (p=0.05) after PTCA, TAPSE value was 2.7±0.4 before PTCA and 2.9±0.3 (p=0.01) after PTCA, right ventricular IVA value was 4.1±1.6 before the process and 5.5±2.2 (p=0.0001) after the process. **Discussion:** In our study we showed that successful revascularisation provides more improvement in right ventricular functions and this improvement can be determined by tissue Doppler, IVA objectively.

Keywords

Right Ventricle; Angioplasty; Coronary Artery Disease

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Introduction

Right ventricle is rarely affected by myocardial ischemia, myocardial muscle and valve diseases because of its anatomical structure. Despite of the poor data it is reported that right ventricle functions decline in many diseases and this causes important clinical effects during the course of these diseases[1]. Clinically right ventricular function disorders can be known as right heart failure. It is possible that right ventricular abnormal filling and contraction may occur without heart failure clinic. One of the most important parameters evaluating right ventricular functions is right ventricle ejection fraction[1]. But it causes false comments as it is affected by volume load. The studies carried out recently have mentioned that tricuspid annular isovolumic myocardial acceleration time (IVA), determined by tissue Doppler is a reliable parameter independent from pre end post load for evaluating right ventricular functions[2]. Coronary artery diseases are seen frequently in our country similar to its frequency worldwide. One of the treatment options of coronary artery diseases is percutaneous transluminal coronary angioplasty (PTCA). In this study we investigated whether successful right coronary angioplasty causes changes in right ventricular functions or not in patients without right heart failure findings.

Material and Method

33 patients whose coronary angiographies had been performed for stable coronary artery disease and who were admitted for elective proximal right coronary angioplasty were included. Patients were selected among patients with preserved left and right ventricular functions and no comorbid diseases or history of myocardial infarction. The mean age was 57.6±9 years (29 men, 4 women). The exclusion criteria were; insufficiency of echocardiographic image, chronic obstructive lung disease, cardiomyopathies, arrhythmias such as AV conduction defects or atrial fibrillation and systemic congestion.

Transthoracic echocardiography and Doppler imaging

All patients included were evaluated by transthoracic echocardiography, GE-Vingmed Vivid 3 system (GE-Vingmed Ultrasound AS, Horten, Norway) using multiHz probe transducer in left lateral decubitus position 4-6 hours before catheterization and within the first 24 hours after the process without changing their treatments. Measurements were made according to American Heart Association criteria[3]. Doppler recordings were made at 100 mm/sec in velocity with simultaneous one derivation ECG recording. All measurements were made in three consecutive cycles and mean values were recorded. All Doppler measurements were made at the end of expiration to avoid respiratory changes and provide flow parameters to be more consistent. Ejection fraction was measured for left ventricular systolic functions and early transmitral flow velocity (E), late diastolic flow velocity (A), peak late and early velocity ratio (E/A), E wave deceleration time (DT) was measured for left ventricular diastolic functions. Right ventricle ejection fraction, M-mode, Doppler and tissue Doppler recordings were made as indicators of right ventricular systolic and diastolic functions. Right ventricular early flow velocity (E), late diastolic flow velocity (A), peak late and early flow velocity ratio (E/A), tricuspid valve

annular plane systolic excursions (TAPSE), myocardial performance index (MPI) and isovolumetric acceleration time (IVA) were measured.

Tricuspid Valve Annular Plane Systolic Excursion (TAPSE) Measurement

Tricuspid Valve Annular Plane Systolic Excursion (TAPSE), an indicator of right ventricular systolic functions, was measured in apical four chamber view. It was estimated by odds between end diastolic and end systolic lines (ms) in trace between right ventricle lateral tricuspid annulus and ultrasound fan origin in apical four chamber view[4]. TAPSE value greater than 2 cm and its slope as 4-5 cm/sn is accepted as normal.

Myocardial Performance Index (MPI):

Doppler time intervals tricuspid inflow and right ventricle outflow Doppler traces were measured for right ventricle performance index. Tricuspid flow Doppler trace was measured by putting pulse wave Doppler sample volume on the tips of tricuspid valve in apical four chamber view. Isovolumic contraction (IVC), isovolumic relaxation (IVR) and ejection time (ET) were determined. Right ventricular myocardial performance index (MPI-Tei index), was estimated by dividing the sum of IVR and IVT to ET[5]. The rate of MPI change (%MPI) after revascularisation was estimated as follows: %MPI= (Basal MPI)-(MPI after Revascularisation)×100)/(Basal MPI).

Isovolumetric Acceleration Time (IVA)

It is measured by putting pulse wave tissue Doppler on right ventricle free wall-tricuspid annulus border in apical four chamber view. Peak myocardial velocity (IVV m/sec) during isovolumic contraction, acceleration during isovolumic contraction (IVA m/sec²), peak systolic flow (St m/sec), and basal line-peak velocity time (acceleration time, AT) during isovolumic contraction were measured as tissue doppler velocity parameters. IVA was estimated by dividing the maximum velocity of the wave occurring just before R peak on ECG and takes place in front of systolic wave of tissue Doppler trace the time interval to peak velocity (IVA: IVV/AT).

Coronary angiography and angioplasty

All patients underwent control angiography before PTCA. 70% or more luminal obstructions in major epicardial arteries were accepted as significant coronary artery disease. All patients had proximal right coronary artery lesion. TIMI flow grading was made accompanied by two independent cardiologists before and after the process. Angioplasties with residual lesions of 30% or less were accepted as successful processes. Mortality, myocardial infarction or emergent surgery necessity during hospital stay was considered as clinical success of the process.

Statistics

Statistics were obtained using the ready-to-use program of SPSS version 11.5. Categorical variables are reported as frequency and group percentages. Continuous variables are presented as means ± standart deviation. The Wilcoxon test was used to compare the dependent variables obtained before and after measurements. P<0.05 was accepted as statistically significant.

Findings

Demographic characteristics of patients are showed in Table 1. All patients had proximal right coronary artery lesion. There was no complication during hospital stay. The echocardiographic findings of patients before and after revascularisation are summarized in Table 2. When right ventricle functions were evaluated there was significant changes in right ventricle TAPSE, IVA, MPI values measured before and after PTCA process. TAPSE was 2.7 ± 0.4 before PTCA and 2.9 ± 0.3 after PTCA ($p=0.01$), right ventricle IVA value was 4.1 ± 1.6 before PTCA and 5.5 ± 2.2 after PTCA ($p=0.0001$), for MPI these values were 0.39 ± 0.64 and 0.37 ± 0.61 ($p=0.05$) respectively. These findings show that successful revascularization provides further improvement in right ventricular functions (Figure 1).

Table 1. The demographic characteristics and echocardiographic findings of left ventricular functions

Variables (n:33)	Value
Age, year	$57.6 \pm 9^*$
Gender (female/male)	4/29
Diabetes Mellitus, n(%)	9 (27)
Hyperlipidemia, n(%)	13 (39)
Hypertension, n(%)	17 (51)
Current smoker, n(%)	15 (45)
Left Ventricular Echo Parameters	
Ejection fraction(%)	$63.4 \pm 6^*$
LVEDD(cm)	$5.09 \pm 0.5^*$
LVESD(cm)	$3.2 \pm 0.5^*$
Septum Diameter (cm)	$0.97 \pm 0.1^*$
Posterior Wall Diameter (cm)	$1 \pm 0.08^*$

LVEDD; Left ventricular enddiastolic diameter, LVESD; Left ventricular endsystolic diameter, (*)Data are expressed as means \pm SD

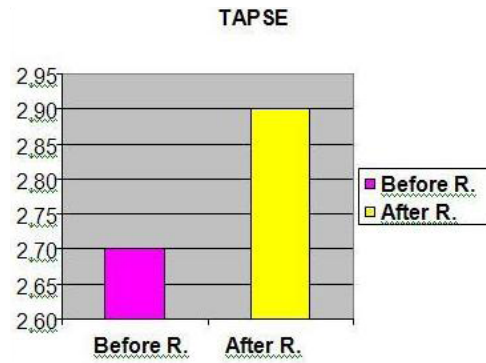
Table 2. The effects of successful revascularisation on right ventricular functions

Variables	Before PTCA	After PTCA	P value
Right atrial diameter(cm)	4.2 ± 0.5	4.2 ± 0.5	NS
Right ventricular diastolic diameter(cm)	2.8 ± 0.5	2.7 ± 0.4	NS
Right ventricular systolic diameter(cm)	2.1 ± 0.4	1.9 ± 0.4	NS
Right ventricular ejection fraction(%)	50.4 ± 3.8	50.8 ± 3.5	NS
RV(St)	13.6 ± 2.8	13.9 ± 2.5	NS
Et/At of tricuspid anulus	0.69 ± 0.21	0.65 ± 0.15	NS
RV MPI(tei indeks-SaV)	0.39 ± 0.64	0.37 ± 0.61	0.05
TAPSE(cm)	2.7 ± 0.4	2.9 ± 0.38	0.01
RV IVA	4.13 ± 1.6	5.5 ± 2.2	0.0001

NS, nonsignificant, Data are expressed as means \pm SD, PTCA; Percutan transluminal angioplasty, RV (St); Right ventricular systolic myocardial velocity, RV Et; Early diastolic velocity of tricuspid anulus, At; Late diastolic velocity of tricuspid anulus, MPI; Miyocardial performance index, TAPSE; Triküspid Valve Annular Plane Systolic Excursion, IVA; Isovolumetric Acceleration Time

Discussion

Chronic ischemia causes leads in patients with coronary artery diseases. Echocardiographic indexes evaluating systolic and diastolic functions of myocardium are used for coronary artery disease diagnosis. Frequently, when the left ventricular functions of patients with coronary artery disease are evaluated, right ventricle is neglected. Right ventricle plays an important role in pulmonary artery perfusion pressure and gas exchange in lungs. On the other hand right ventricle lowers systemic venous pressure and thus protects tissues and organs from congestion.



TAPSE; Triküspid Valve Annular Plane Systolic Excursion, R; Revascularisation

Figure 1. Comparison the successful revascularization provides further improvement in right ventricular functions (TAPSE and IVA)

It also effects left ventricular functions because of preload and ventricular dependence. Right ventricle ejection fraction is an indicator for increased mortality in patients with coronary artery disease and heart failure[6]. Right ventricle is also a critical indicator for short term prognosis in patients with end stage chronic heart failure patients[7].

Right ventricle functions are usually evaluated by EF or tissue Doppler measurements made on tricuspid annulus. But anatomical structure of right ventricle causes restrictions for standard echocardiographic evaluation[8]. Echocardiographic measurements of right ventricle depend on preload, post load, age, localization of Doppler sample volume, heart rate and rhythm[9;10]. Recently parameters independent from preload and heart rate have been used safely. A new Doppler index which combines systolic and diastolic functions is called MPI and this index was firstly used by Tei et al[5]. Because of its correlation with invasive measurements, its repeatability, and being easily measurable MPI have been more widely used. The lengthening of MPI occurs before left ventricular functional disorders and it was reported to be an important predictor in patients with coronary artery disease[11]. Right ventricular MPI is showed to be 0.28 ± 0.04 in healthy subjects[12]. It is possible to determine systolic and diastolic tricuspid annulus velocities and time intervals by PW DD. Right ventricle functions can be evaluated by systolic wave (St) which is formed during systolic ejection[12]. Similarly Et, At and Et/At ratio can be used to evaluate right ventricular functions.

Late diastolic velocities increase while peak systolic velocities and early diastolic velocities decrease[13]. When systolic annular velocity is under 11.5 m/sec, it shows right ventricle EF is under 50% with a sensitivity of 90% and a specificity of 85%.

The shortening of isovolumic acceleration time has been showed to be an early predictor of right ventricular systolic dysfunction[14;15]. Voegle et al reported that right ventricle IVA measured by tissue Doppler is a reliable parameter for right ventricular contractions and does not depend on volume load [2]. Recently IVA determined by tissue Doppler has been found to be a reliable parameter independent from pre and post load changes in evaluating right ventricular systolic functions. We found similar results in our study.

It is possible to meet studies investigating positive effects of acute ischemia on right ventricular functions in the literature.

But we did not meet any study comparing right ventricular functions of patients with isolated right coronary artery disease with normal subjects or patients undergoing PTCA.

In conclusion successful right coronary angioplasty may prove useful in improvement of right ventricular functions in short term, and may be shown with improved IVA results. This may lead to better functional capacity. We believe in that data from further multicenter studies, IVA will provide us useful knowledge for following patients undergoing angioplasty and predicting restenosis.

Competing interests

The authors declare that they have no competing interests.

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